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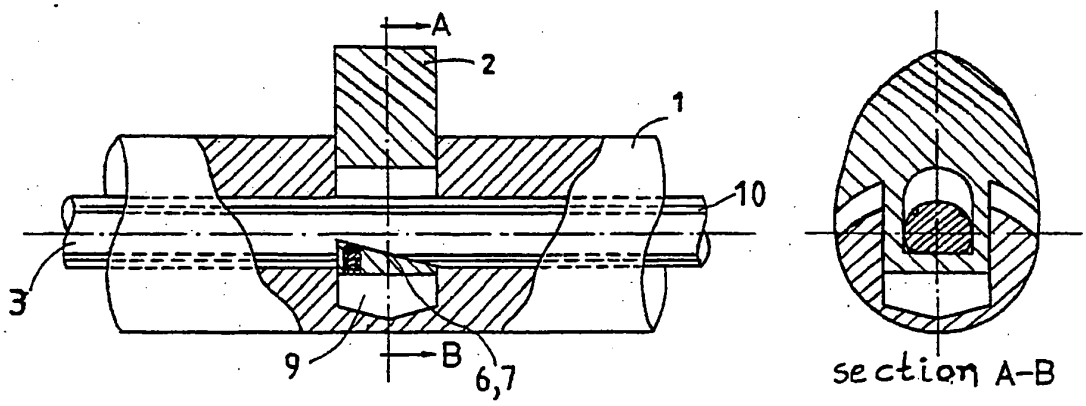
(54) **Title:** VARIABLE ACTION ARROWHEAD SHAPED CAM LOBE SYSTEM



(57) **Abstract**

Variable action arrowhead shaped cam lobe system properly shaped so that it can cooperate completely with rotating shaft having a longitudinal hole for bearing lubrication, through which hole and a transverse opening, a combined hydraulic and mechanical action moves and changes gradually the lifting of the above-mentioned lobe and simultaneously allows the successive change of the lifting of the valves of the respective cylinder.

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DESCRIPTION

Variable action arrowhead shaped cam lobe system.

FIED OF THE INVENTION

The invention refers to a new system and method that provides the capability to an arrowhead shaped cam lobe to move gradually between a lower and an upper position, changing therefore gradually and succesively the lifting of the valves of the respective cylinder of an Internal Combustion Engine (I.C.E.), with the purpose of improving the basic operational characteristics and the efficiency of the I.C.E.

BACKGROUND OF THE INVENTION

Systems that would reduce the disadvandages occuring in the operation of I.C.E., equiped with conventional camshafts, have been apllied in a very limited extend and in certain I.C.E. sofar.

Refering to the invention with Patent No. DE 42 22 477 A1 which refers to a variable cam, which operates whether through its fixed cam segment or through the combination of fixed-movable segment, we observe that in this invention:

a) The hydraulic means for transmitting moving action to the cam, succeeds in moving the cam to the "out" position and returning it to the "in" position, with result the limiting of the torque and power improvement of the engine, only in certain positions.

b) It has serious tightness problems in the hydraulic pressure chamber, due to the size of the chamber, the complicated system, the necessary high hydraulic pressure for holding the cam on the "out" position, where the cam is forced down from the respective valve lifter.

c) The cams due to the increased solid mass, especially in the configuration FIG.9, will develop during their operation serious problems from inertia forces.

d) Obvious manufacturing and assemblying difficulties. (FIG. 2,3,9).

e) It cannct be applied to engines where the distances between the cams are limited, as for example with the engines V6 and V8 used by thg autoindustries in the U.S.A., CANADA, AUSTRALIA etc.

The present invention respectively is succesfull in:

a) Smooth and graduall raising and returning of a

properly shaped cam lobe employing also the important advantage, concerning the valves of the same cylinder, of having the gradual change of the valve lifting of one valve to be preceded by a proper time space to the other, in such a way as to result in smoother distribution of torque and power of the engine in its r.p.m. range.

b) Complete tightness of the small required hydraulic pressure chamber, in the lower cylindrical portion of the cam lobe, where it is required only the supplied hydraulic pressure from the lubrication system of the engine, resulting in the application of the invention without any problem.

c) Safe and smooth raising of the cam lobe and resting on the cylindrical recess of the rotating shaft. Minimisation of load and inetria forces problems.

d) The present invention allows also the simple, fast and economical manufacturing of the cam and the other elements and ease of assemblying as it is obvious from the following drawings.

e) It is applied in all existing I.C.E. types without any need for design change.

BRIEF DESCRIPTION OF DRAWINGS

FIG.1 : Shows views of the rotating shaft.

FIG.2 : Shows the above mentioned system with the cam lobe on its initial position.

FIG.3 : Shows the above mentioned system with the cam lobe on its final position.

FIG.4 : Shows views of the longitundinal reciprocating shaft.

FIG.5 : Shows a special configuration of the above mentioned shaft.

FIG.6 : Shows several views of the arrowhead shaped cam lobe.

FIG.7 : Shows a special design of the cam lobe.

FIG.8 : Shows a mounting system of cam lobes on a simple construction allowing the grinding in pairs.

DETAILED DESCRIPTION OF THE INVENTION

Refering to the Drawings 1,2,3,4,6 we observe that the system consists of the rotating shaft (1), which is equiped with the arrowhead shaped movable cam lobes (2), the longitudinal reciprocating shaft (3), the ball (4) and the spring

(5). The cam lobe has a special cylindrical configuration on its lower end, so that it can be assembled in the respective cylindrical opening of the shaft (1) in a secure way. It has also a longitundinal opening through which the shaft (3) passes. In the inside of the opening the inclined ramp (6) is shaped, and corresponds with the slope of the ramp (7) on shaft (3). This shaft has an appropriate number of longitudinal grooves, through these grooves the circulation under pressure of the hydraulic fluid, used also for I.C.E. lubrication, is eased, so that the areas on shaft (1) equiped with the cam lobes are always under hydraulic pressure, which pressure is also supplied for the lubrication of the engine. This pressure is adequate in any case to overcome the reaction of spring (5) and the hydraulic fluid passes through the vertical hole (11) of the lobe and floods the chamber (9) between the shaft (1) and the cam lobe (2). In this way the cam lobe (2), forced by the fluid, is raised untill the lobe ramp (6) coincides with the ramp (7) of the shaft (3). In this position the lobe remains raised thanks to the following mechanism:

During the time that the cam lobe is not in contact with the respective valve lifter the lobe (2) and the shaft (3) remain in contact since the ramps (6) and (7) coincide. In this case the ball (4) is completely inside the vertical hole (11) (spring retracted) simply touching the ramp (7). As soon as the lobe comes in contact with the respective valve lifter, a force is applied on it greater that the force applied by the hydraulic fluid in chamber (9), and momentarily it gives in. This retreat results in the upward movement of the ball (4), through the spring (5), and the complete fit on the specially shaped, like a seating,upper part of hole (11), making the whole space tight and at the same time capturing the hydraulic fluid inside the chamber (9), so that no further retreat of the lobe is possible during the hole time of its conctact with the valve lifter (FIG.6).

Movement of the shaft (3) towards the direction (a) (FIG.3) results in pushing back to a certain distance the ramp (7) from ramp (6). Respectively the under pressure hydraulic fluid passing through the vertical hole (11)

forces the cam lobe upwards untill the ramps (6) and (7) come again in contact. In this way and according to the mechanism we described earlier the lobe is secured in a new position during its contact with the respective valve lifter. This procedure can be repeated untill the cam lobe takes its upper position, depending on the configuration (length, slope) of the ramp (7) on shaft (3).

The gradual retraction of the lobe to its initial position is achieved by the gradual movement of the shaft (3) towards the opposite direction. Indeed this movement results initially in pushing the ball (4) by ramp (7) which penetrates inside the hole (11), and further more in pushing the ramp (6), with the final result the whole lobe to move downwards. The hydraulic fluid in chamber (9) can escape through the vertical hole (11), since the ball (4), being already pushed by the ramp (7) does not rest on the upper "seating" end of hole (11), and does not provide therefore any tightness in the chamber (9). In any intermediate position the lobe is secured by the mechanism already described (Page 3 lines 21-36).

Refering to FIG.3 we observe a special configuration of the longitudinal shaft (3), which is forseen so that the change in lifting of a valve through the ramp (7) to follow, at a proper time lapse, the change in lifting of another valve of the same cylinder through the ramp (7a), so that a smoother distribution of the torque and power of the engine is achieved through the whole range of its r.p.m. range.

Refering to FIG.7 we see a configuration of the cam lobe consisting of two parts assembled together with a tight fit for reasons of manufacturing ease.

The above mentioned cam lobe properly shaped, cooperates as its different positions completely with the cylindrical base of the rotating shaft (1). Obviously the above mentioned cam lobe can cooperate with fixed cams too.

Concerning the grinding of cams, as it is well known, this is executed with the method of copying tool machines through the respective PROFILE-MASTER CAM. With conventional cams the grinding procedure is executed on one cam

each time (FIG. 8,b2) through the PROFILE-MASTER CAM (FIG. 8, b1). On the other hand with the cam lobe configuration of the present invention the grinding procedure is executed in pairs of cam lobes mounted on a simple construction (FIG. 8, a2, a3) through the special PROFILE-MASTER CAM (FIG.8,a1), which method is obviously faster and more economical, than the conventional method usually applied.

CLAIMS

1. Variable action arrowhead shaped camlobe system characterized by the fact that it changes gradually, the lifting of the lobe and simultaneously it allows the succesive change of the valve lifting of the valves of the respective cylinder of an Internal Combustion Engine and includes:

a) One at least movable cam lobe properly chaped to an arrowhead figure (FIG.6) resting on a proper opening and hole of the rotating shaft (FIG.2).

b) A rotating shaft with a longitudinal hole for lubricating the bearing seats and transverse vertical hole on it (FIG.1).

c) A combined hydraulic and mechanical system, which through a properly shaped reciprocating shaft (FIG.4) inside the longitudinal hole of the rotating shaft acts on the vertical transverse hole (FIG. 3,6) and moves the specially shaped lobe, acting constantly under the hydraulic pressure only, provided by the lubrication fluid pressure of the engine.

This system improves the basic operational characteristics and the efficiency of the Internal Combustion Engine with the gradual and succesive lifting of its valves.

2. Variable action arrowhead shaped cam lobe system according to claim 1 characterized by the fact that the moving cam lobe is properly shaped in an arrowhead figure so that its lower cylindrical portion, penetrating the transverse opening of the rotating shaft and resting on it, coincides on its side curved surfaces, with the curved surface of the rotating shaft, which constitutes with the lobe the cyclic base (RUN OUT) of an unified cam in the present claim (FIG.2) cooperating smoothly and constantly with it, resulting in the smooth and without obstacles sliding of the lifter (or fulcrum or roller tappet) during the whole time of its movement.

3. Variable action arrowhead shaped cam lobe system according to claim 1, characterized by the fact that as means for its movement is used a combined hydraulic and mechanical system which consists of:

a) a reciprocating shaft inside the longitudinal hole, for bearing lubrication,of the rotating shaft, which has

on its surface longitudinal grooves, for the flow of pressurized fluid and properly shaped sliding surface locations (FIG.4) and

b) a spring and ball acting under each respective sliding surface inside the small space, under hydraulic pressure,on the lower cylindrical part of the moving lobe, characterized by complete tightness. (FIG.6, 3).

This system being constantly under pressure - which is supplied only for the engine lubrication - allows the lobe to move during its extention and retraction gradually and also at the same time allows the succesive change of the valve lifting of the respective cylinder, resulting in the distribution of torque and power through the whole r.p.m. operational range of the engine, applied to all the Internal Combustion Engine rypes.

4. Variable action arrowhead shaped camlobe system according to CLAIM 2 characterized by the fact that the grinding process is possible to be applied on pairs of lobes mounted axialy on the recess of a simple construction where the whole operation is done according to the method followed by the copying maschines through the respective PROFILE-MASTER CAM. This method is obviously faster,and more economical from the cam grinding of the conventional camshafts used by the autoindustry and general industry.

AMENDED CLAIMS

[received by the International Bureau 21 November 1994 (21.11.94); original claim 3 amended; remaining claims unchanged (3 pages)]

1. Variable action arrowhead shaped cam lobe system characterized by the fact that it changes gradually, the lifting of the lobe and simultaneously it allows the succesive change of the lifting of the valves of the respective cylinder of an Internal Combustion Engine and includes:

a) One at least movable cam lobe properly shaped to an arrowhead figure (FIG.6) resting on a proper opening and hole of the rotating shaft (FIG.2).

b) A rotating shaft with a longitudinal hole for lubricating the bearing seats and transverse vertical hole on it (FIG.1).

c) A combined hydraulic and mechanical system, which through a properly shaped reciprocating shaft (FIG.4) inside the longitudinal hole of the rotating shaft acts on the vertical transverse hole (FIG. 3,6) and moves the specially shaped lobe, acting constantly under the hydraulic pressure only, provided by the lubrication fluid pressure of the engine.

This system improves the basic operational characteristics and the efficiency of the Internal Combustion Engine with the gradual and succesive lifting of its valves.

2. Variable action arrowhead shaped cam lobe system according to claim 1 characterized by the fact that the moving cam lobe is properly shaped in an arrowhead figure so that its lower cylindrical portion, penetrating the transverse opening of the rotaring shaft and resting on it, coincides on its side curved surfaces, with the curved surface of the rotating shaft, which constitutes with the lobe the cyclic base (RUN OUT) of an unified cam in the present claim (FIG.2) cooperating smoothly and constantly with it, resulting in the smooth and without obstacles sliding of the lifter (or fulcrum or roller tappet) during the whole time of its movement.

3. Variable action arrowhead shaped cam lobe system according to claim 1, characterized by the fact that as means for its movement is used a combined hydraulic and mechanical system or only the mechanical part of the system. The combined hydraulic and mechanical system consits of:

a) a reciprocating shaft inside the longitudinal hole,for bearing lubrication, of the rotating shaft, which has on its

surface longitudinal grooves, for the flow of pressurized fluid and properly shaped sliding surface locations (FIG.4) and

b) a spring and ball acting under each respective sliding surface inside the small space, under hydraulic pressure, on the lower cylindrical part of the moving lobe, characterized by complete tightness. (FIG. 6,3).

This system being constantly under pressure - which is supplied only for the engine lubrication - allows the lobe to move during its extention and retraction gradually and also at the same time allows the succesive change of the valve lifting of the respective cylinder, resulting in the distribution of torque and power through the whole r.p.m. operational range of the engine, applied to all the Internal Combustion Engine types.

Moreover in the case of a camshaft, where the longitudinal hole of the shaft is not used for the lubrication of the bearing seats it is possible only the mechanical part to be applied with the following arrangement. The ramp (7), on surface of reciprocating shaft (3), must be located on the diametricaly opposite position from the one shown on Fig.2,3,4,5, in the combined hydraulic and mechanical system,in the inside of the cylindrical part of the lobe (Fig.6). In this case the longitudinal hole, through which the cylindrical part of the cam lobe is moved, can be extended to a longitudinal hole through the whole length of the rotating shaft (1),only for ease of manufacturing. The spring and the ball remain in the same position (Fig.6) and insure the retraction of the lobe as well as the dambing of vibration and noise during the lobe movement. This operation, during the application of the mechanical means of transmission of the movement, allows the same exactly movement of the specially shaped cam lobe, and consequently the improvement of the operational characteristics of the motor, as described in detail, before, in the case of the application of the combined hydraulic and mechanical means and shown on the respective drawings of the internal application.

4. Variable action arrowhead shaped camlobe system according to CLAIM 2 characterized by the fact that the grinding process is possible to be applied on pairs of lobes mounted axialy on

the recess of a simple construction where the whole operation is done according to the method followed by the copying mashines through the respective PROFILE-MASTER CAM. This method is obviously faster and more economical from the cam grinding of the conventional cam-shafts used by the autoindustry and general industry.

Statement under Article 19

The amendment of the text of the initial claim 3, refers to the possibility of operating the system for moving the lobe, only with the mechanical part of the referd in this claim hydraulic and mechanical system, and is applied in the case, where the lubrication of the bearings seats of the camshat is not achieved through the longitudinal hole of the shaft.

Consequently the description, as it is, in the already searched application No PCT/ GR 94/ 00002, has to be completed with the description of the amendment of the initial claim 3, because it refers only, to the mechanical means of transmitting the movement and specificaly only,to the location change of the ramps (6) and (7) of the respective drawings of the above mentioned international application, as defined in detail in the following lines.

Fig. 2,3,4,5: The ramp (7) on the reciprocating shaft (3) surface has to be moved to the diametricaly opposite position.

Fig. 2,3,6: The inclined ramp (6) inthe inside opening of the cylindrical part of the lobe has to be moved to a new sliding position in respect with the ramp (7).

The spring and ball (Fig.6) remain in the same position.

It should be pointed out that:

a) all the rest of the description and of the drawings included in the international application remain unchanged.

b) in the both the referred cases of the amended claim 3 the movement of the specially shaped lobe, as well as the improvement of the motor operational characteristics are identical.

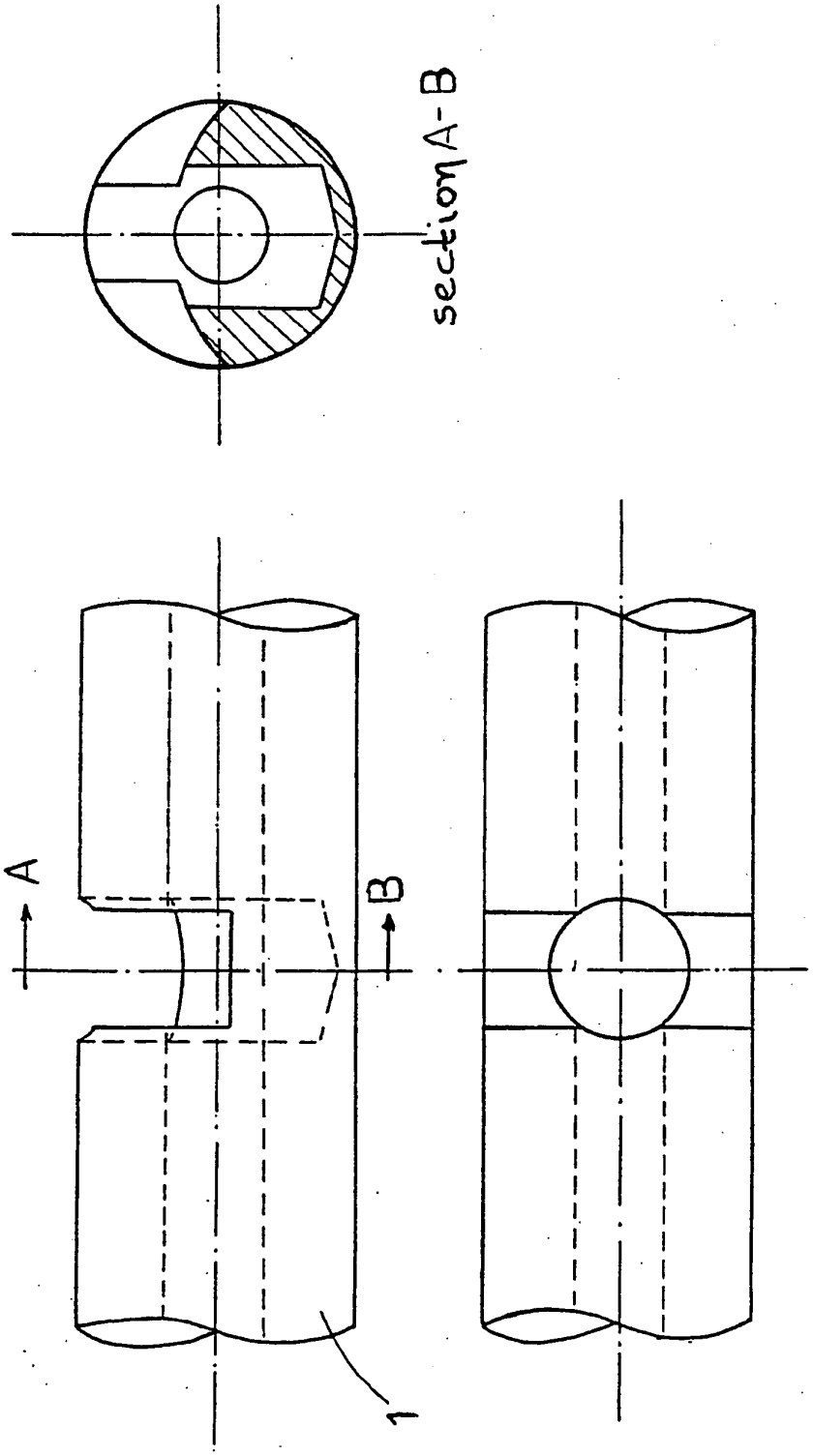


Fig. 1

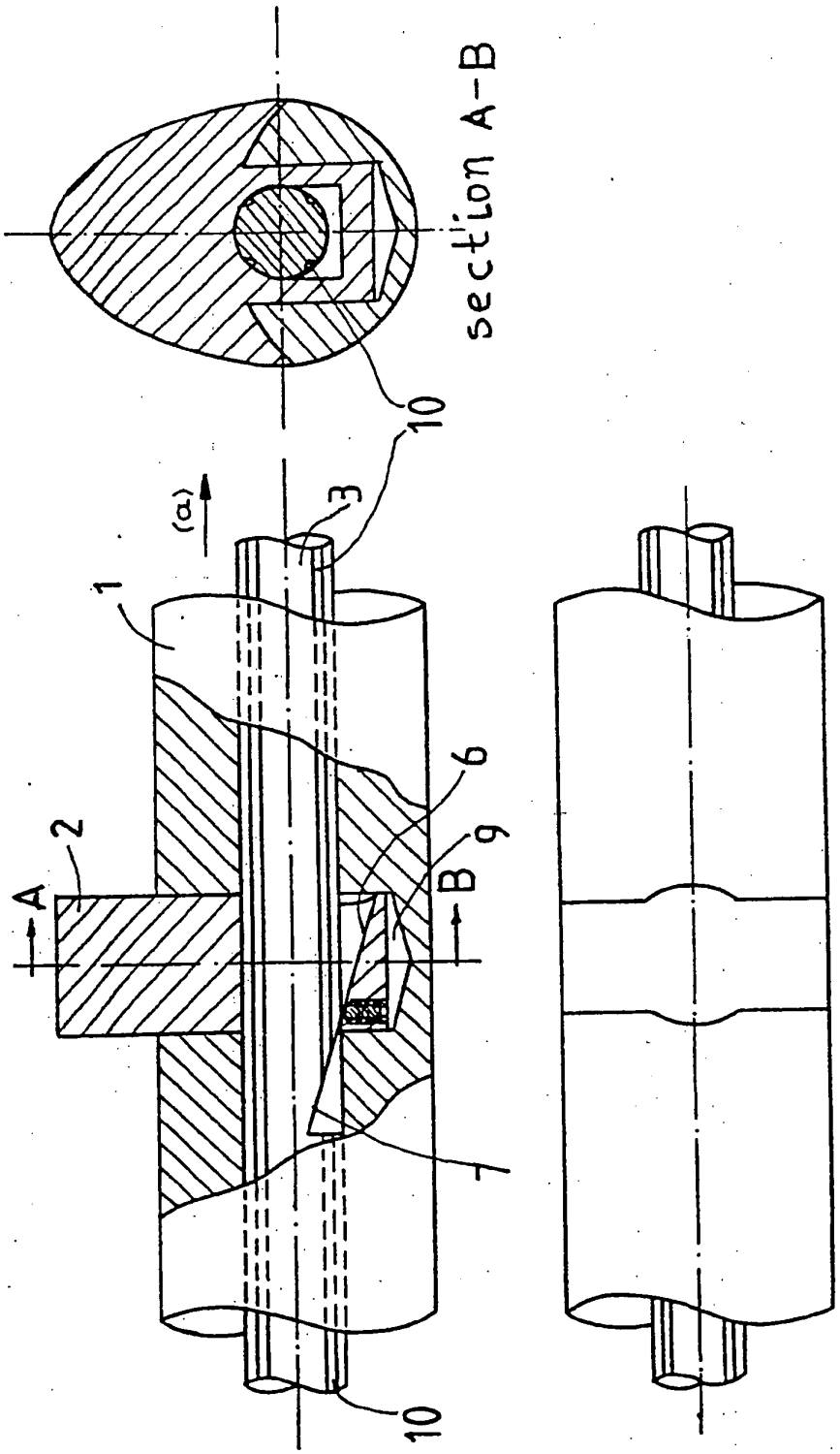


Fig. 2

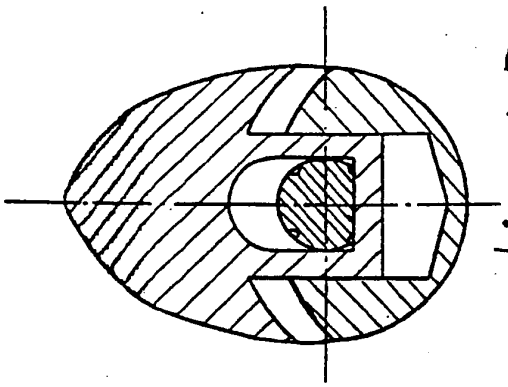
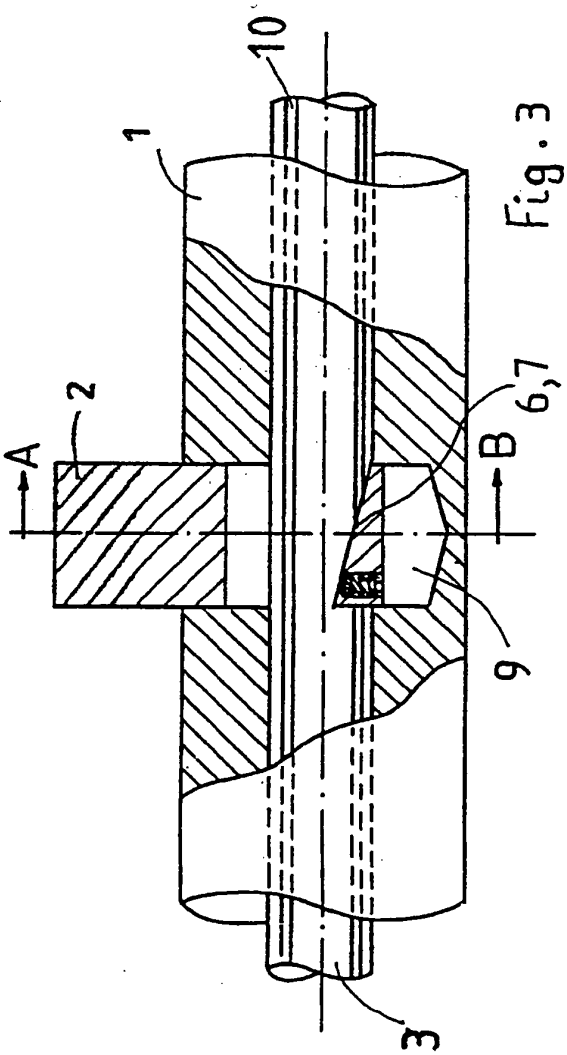


Fig. 3



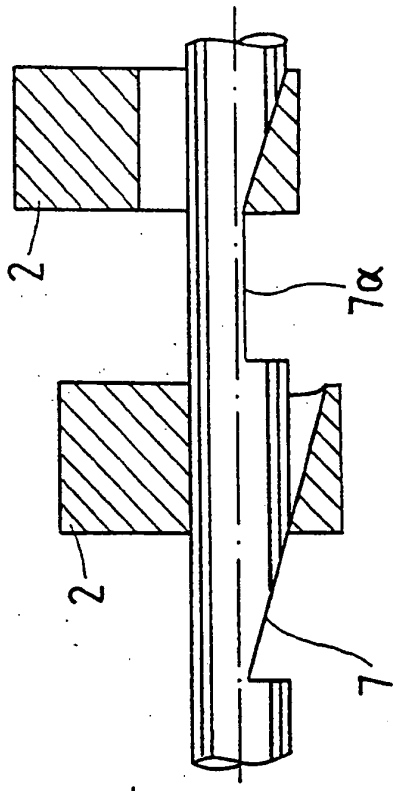


Fig. 5

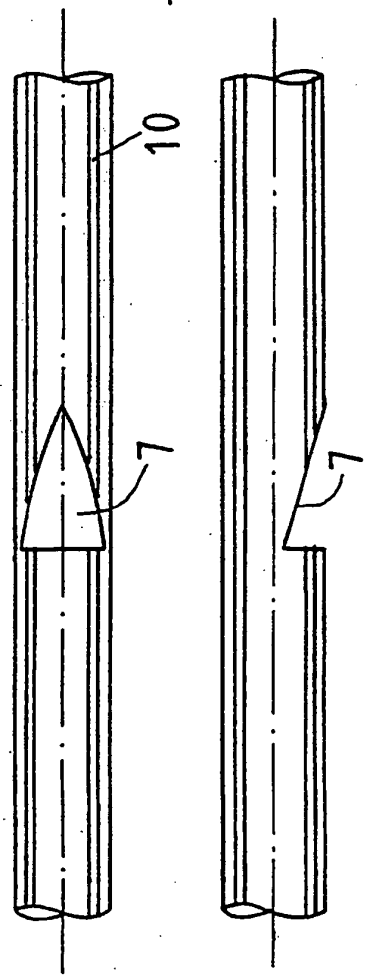


Fig 4

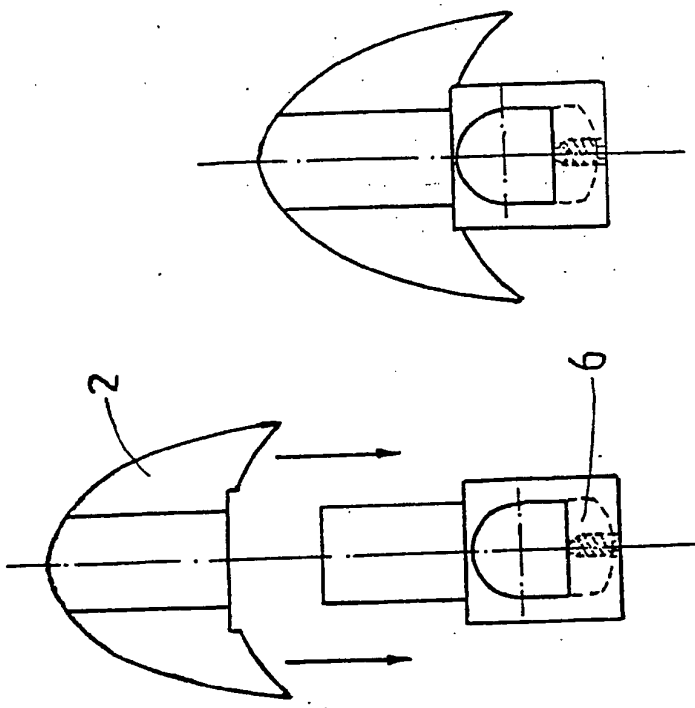


Fig. 7

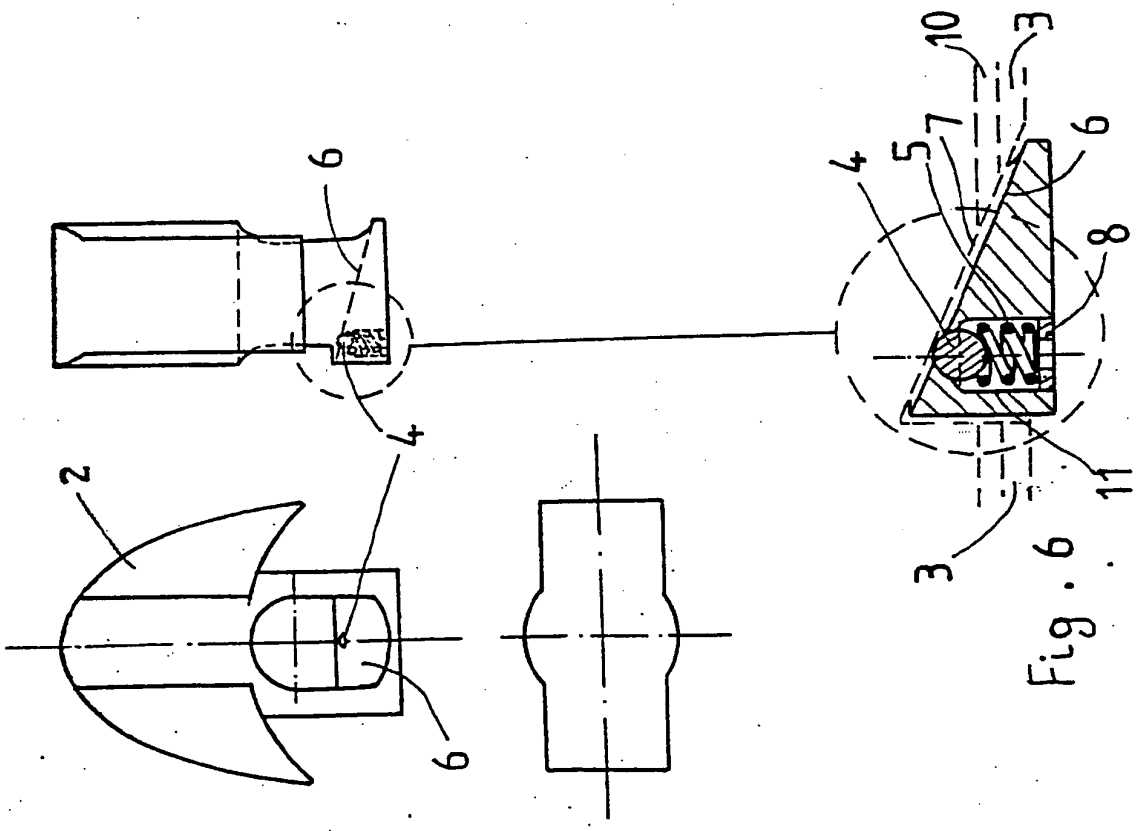


Fig. 6

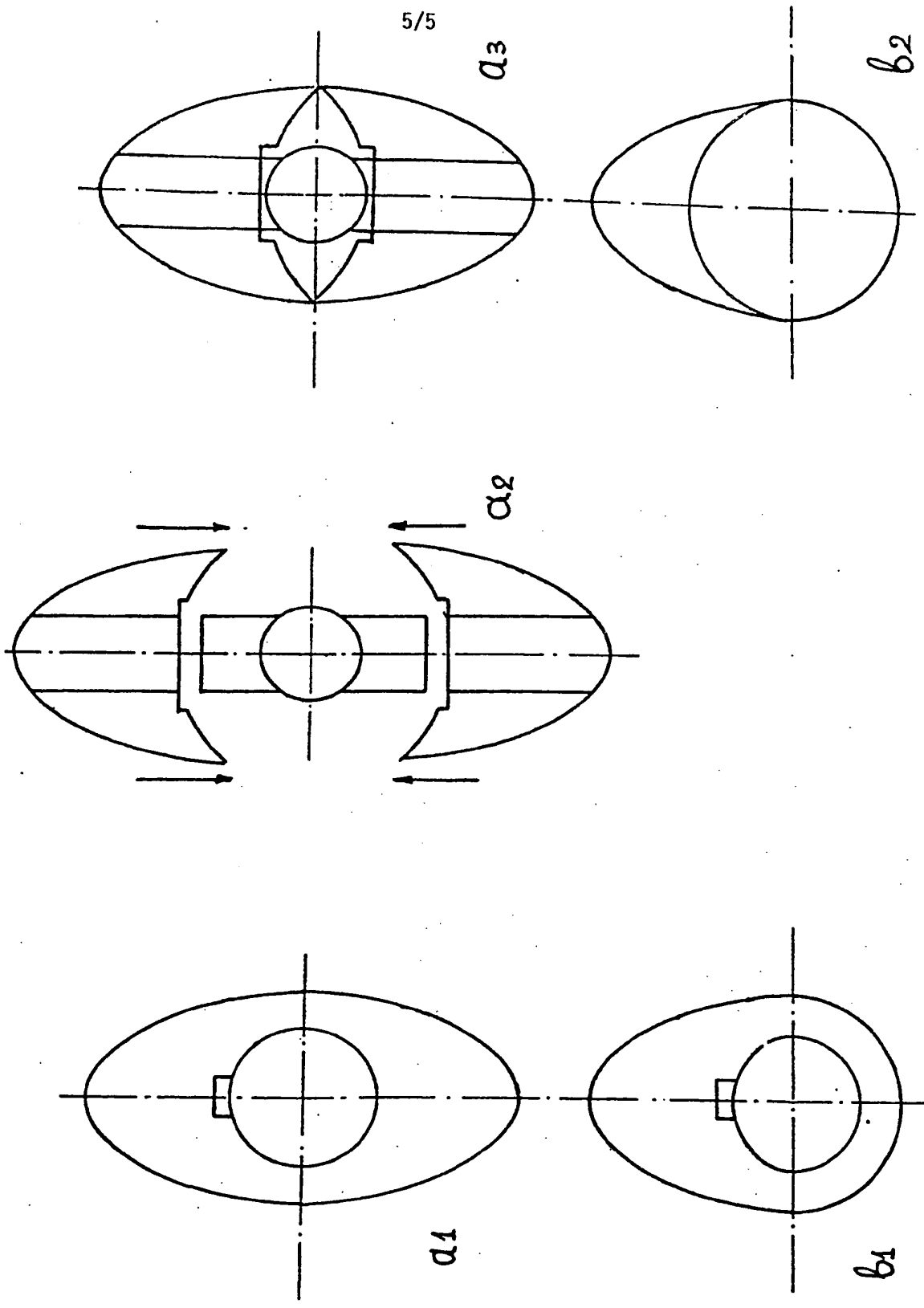


Fig. 8

INTERNATIONAL SEARCH REPORT

Interna al Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 F01L13/00

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 F01L

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A,2 025 600 (LOOP ET AL) 24 December 1935 see the whole document	1,2
A	DE,A,37 05 128 (OPEL) 1 September 1988 see column 3, line 54 - column 4, line 17; figures 2,3	1,2
A	US,A,3 523 465 (HARRELL) 11 August 1970 see the whole document	1,2
A	PATENT ABSTRACTS OF JAPAN vol. 9, no. 249 (M-419) 5 October 1985 & JP,A,60 101 205 (SHINSUKE TAKAHASHI) 5 June 1985 see abstract	1

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[X] Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search	Date of mailing of the international search report
16 August 1994	23.09.94

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+ 31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+ 31-70) 340-3016	Klinger, T

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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	FR,A,322 489 (PANHARD ET LEVASSOR) 25 June 1902	

1

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INTERNATIONAL SEARCH REPORT

Information on patent family members

Internat. Application No
PCT/GR 94/00002

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US-A-2025600		NONE	
DE-A-3705128	01-09-88	NONE	
US-A-3523465	11-08-70	NONE	
FR-A-322489		NONE	